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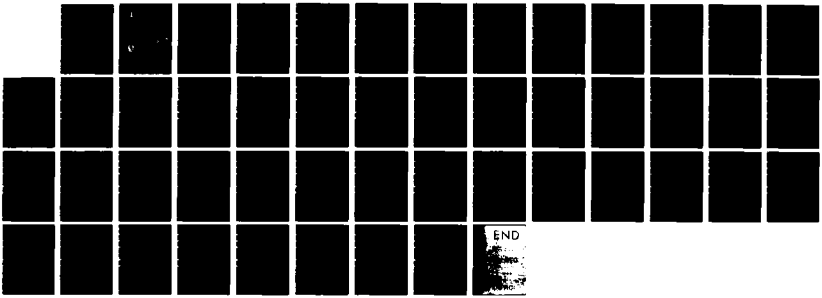

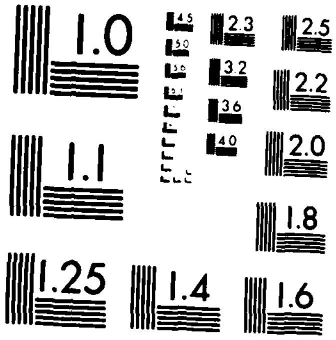

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TECHNICAL REPORT RR-84-6

INTERRELATIONSHIP OF ATMOSPHERIC PARAMETERS IN HONDURAS

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June 1984

U.S. ARMY MISSILE COMMAND
Redstone Arsenal, Alabama 35898

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This report summarizes a thorough literature survey of Honduran climate and a small amount of supplementary material from neighboring countries. The results are compared with an analysis of three-hourly meteorological data from Tela and Tegucigalpa for the period 1973-1981. Honduras is a small Central American country which has a varied climate because of the extremely uneven terrain. Diurnal variations of temperature are larger than seasonal variations, and the mean depends primarily upon elevation. Seasonal variations of absolute humidity are greater than diurnal variations, and the means are larger in the coastal areas.

20. (Continued)

Diurnal variations of wind speed are larger than seasonal variations, and speeds are larger in mountainous areas. Visibilities are typically lower in spring throughout Honduras than during the other seasons. Precipitation is the element which is most variable in space and time, and even the mean has a very complex spatial pattern. This report also includes information about cloud amounts and solar radiation.

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I. INTRODUCTION

The map in Figure 1 shows that the Republic of Honduras is a small Central American country. It has an area of only 109,560 square kilometers (Gale Research Co., 1983). The northern coast is along the Caribbean Sea, and a small part of the southwestern border of the country is along the Pacific Ocean. Honduras has additional borders with Guatemala, El Salvador, and Nicaragua. Several islands are also part of the country (Young, 1982). The Bay Islands of Roatan, Utila, Guanaja, Barbereta, Santa Elena, and Morat lie near the northern coast of Honduras. The two small Swan Islands (17°23'N, 83°56'W) were officially ceded to Honduras by the United States on 20 November 1971 (Worldmark Press, 1976). Honduras has a Pacific port, Amapala, on Tiger Island in the Gulf of Fonseca.

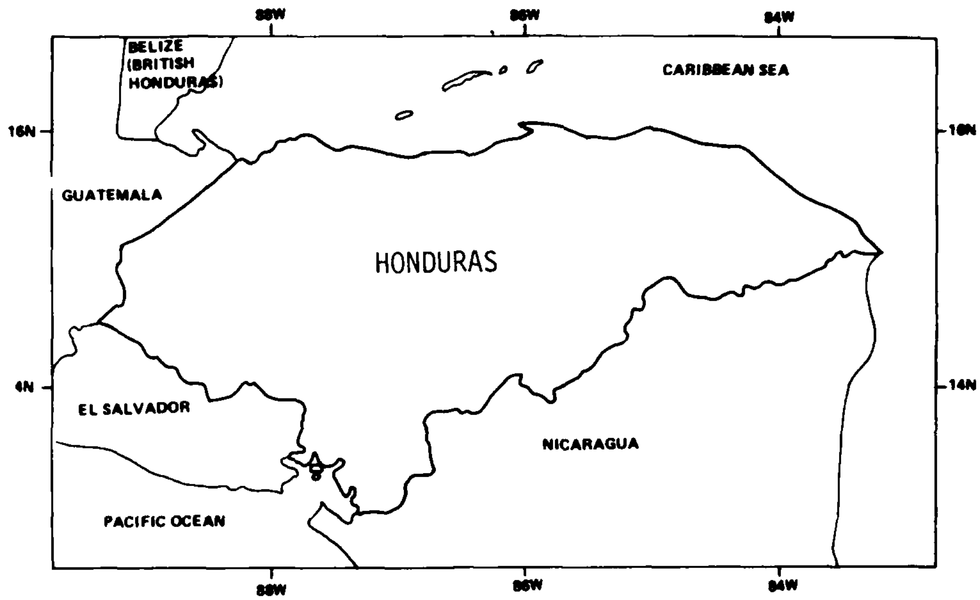

Figure 1. Map of Honduras

The climate of this small country is not uniform because the terrain is quite uneven. It is estimated that 63.6 percent of the land surface is mountainous (Young, 1982). In the mountainous interior some elevations are nearly 3 km (Worldmark Press, 1976). The highest meteorological observing station is La Esperanza (14°16'N, 88°10'W) at 1979 m (Wernstedt, 1972). Most stations are below 1.3 km because this is where most of the population is located. For example, the capital, Tegucigalpa (14°03'N, 87°13'W), barely lies above 1 km, but it is surrounded by peaks higher than 1.8 km (Young, 1982).

Wet, tropical climates prevail along both coasts, but the climate is cooler and drier in the mountainous interior. Relatively dry valleys are typically surrounded by well watered mountains in Central America (Rumney, 1968). The vertical meteorological station network does not adequately document this in Honduras. However, the distribution of vegetation suggests that rainfall increases upward from the bottom of arid interior basins in the dry season (Johannessen, 1959; Hastenrath, 1967). A dry season occurs in the cooler part of the year in almost all of Honduras (Gramzow and Henry, 1972).

Variations of climate throughout Honduras are discussed in more detail in the following sections of this report. Information from a thorough literature survey is supplemented by extracts from tabulations created from original data by the authors. In a few cases the discussion includes data from neighboring countries and oceanic areas.

II. TEMPERATURE, DEW POINT, AND HUMIDITY

Annual mean temperatures depend primarily on elevation, and month-to-month variations of temperature are small. This can be seen in Table 1 which lists stations in order of decreasing mean annual temperature. Data in Table 1 were taken primarily from Wernstedt (1972). Additional data were obtained from Environmental Science Services Asministration (1966) and Rudloff (1981). The annual mean temperature for Amapala at 16 feet is 83.8°F, but La Esperanza at 6494 feet has a mean annual temperature of only 63.8°F. At Amapala the mean temperature difference between the warmest month and the coolest month is only 4.8°F. The difference between warmest and coolest months at La Esperanza is 8.5°F. Differences fall within this range at all stations except Comayagua where the mean temperature during the warmest month is 8.8°F greater than the mean temperature during the coldest month.

Year-to-year variations are usually small in Honduras. An Environmental Science Services Administration (1966) publication has data for individual years at eight stations, and for two of these stations the uninterrupted period of record is 10 years. At Tegucigalpa the difference between the annual mean temperature during the warmest and coolest of the 10 years is only 1.6°C (2.88°F). At Tela the corresponding difference is 1.8°C (3.24°F). Year-to-year variations of monthly means are sometimes much larger. For example, the warmest April is 5.6°C (10.08°F) warmer than the coolest April at Tela. At Tegucigalpa the warmest July is 5.0°C (9.0°F) warmer than the coolest July. These are the largest differences between warmest and coolest months at the two stations, but most monthly means have larger year-to-year variations than annual means have.

Table 2 lists absolute maximum and minimum temperatures according to tabulations made by the Aerophysics Group for the years 1973-1981 and three other sources (Johannessen, 1959; US Air Weather Service, 1968; and Showers, 1973) from periods of record before 1973. Temperatures are usually above 40°F near the coasts, and even in the mountainous interior they seldom fall below the freezing point of water. Unfortunately, similar information has not become available to the authors for La Esperanza (6494 feet) or for higher elevations. Maximum temperatures are apparently greater than 90°F in all well populated areas, and temperatures a few degrees above 100°F are possible.

Tables 3 and 4 are based on data from the US Air Weather Service (1968). Conclusions from Tables 3 and 4 must be considered tentative. Most of the data are supported by five or fewer years of record. Mean temperatures inferred from Table 3 are lower than those for the same latitude and longitude in Table 1. Mean temperatures for Tela are very close even though the station has apparently been moved a short distance during the period of record.

Dew points are much lower at the mountainous interior station in Table 3 than at the northern coastal station in Table 4. At Toncotin International mean dew points are lowest at 47°F in March and highest at 67°F in November. At Tela the lowest monthly mean dew point is 68°F which occurs in January and February, and the highest monthly mean dew point is 75°F which occurs from May through

September. As expected, relative humidities are higher and dew point depressions are smaller at Tela.

Using relationships described in the Smithsonian Meteorological Tables (List, 1958) one can estimate the absolute humidity from the available data. The mean values are more than 17 g/m^3 during every month at Tela, and during the warmer half of the year they are greater than 20 g/m^3. Absolute humidities are much lower at Toncotin International but they are still higher than in many locations outside the tropics. The lowest monthly mean is 8.4 g/m^3 in March.

The authors obtained and analyzed three-hourly data for the years 1973-1981 at Tela and Tegucigalpa. Tables 5 and 6 contain seasonal means of temperature and absolute humidity for three-hourly intervals with the exception of 0300 hours local time. Data for 0300 hours were extremely poor. Diurnal variations of temperature are larger than seasonal variations at both Tela and Tegucigalpa. Seasonal variations of absolute humidity are larger than diurnal variations at both stations. Diurnal variations in these tables cannot be compared with other studies of Honduras because such detailed information is not available in the published literature. However, tables and graphs for San Salvador (13°43'N, 89°12'W, 2297 ft) in neighboring El Salvador are available (Hastenrath, 1963b). Hastenrath's article contains graphs of temperature, relative humidity, and vapor pressure as a function of month and hour of the day. Tables of monthly means of various quantities based on 10 years of data are also included in Hastenrath's manuscript, and a majority of these values fall between the corresponding values in Tables 3 and 4. Therefore, it is realistic to compare Table 7 for San Salvador with Tables 5 and 6 for Tela and Tegucigalpa. Mean temperatures at 0600 hours are below 70°F throughout the year at the mountainous stations of San Salvador and Tegucigalpa. Because Tela is a coastal station near sea level, it is not surprising that the winter mean is 69.7°F at 0600 hours and other seasons are warmer. Diurnal variations in Tables 5 through 7 are somewhat smaller than actual diurnal variations. Hastenrath's (1963b) graph of temperature at San Salvador shows that maximum temperatures occur between 1200 and 1500 hours, and minimums occur one-half hour or more before 0600 hours. However, actual diurnal variations are within 2° to 4°F of those inferred from Tables 5 through 7. Diurnal variations at the two mountainous stations are larger than those at the coastal Tela where the 12.5°F in spring is the largest. Monthly differences between mean maxima and minima for Tela range from 14° to 16°F (US Air Weather Service, 1968). The short period of record used in Table 3 for the airport at Tegucigalpa has absolute minimum temperatures a few degrees higher than those for the period 1973-1981 in every season and the differences at Tela (Table 4) are even larger. There is no overlap in the period of record because the US Air Weather Service published its data in 1968. Seasonal means of absolute humidity at Tegucigalpa apparently vary less with period of record, but they are higher in the later period in all seasons except summer. The scope of this study does not permit an investigation to determine if the differences are random fluctuations, large-scale climatic trends, or effects of increased urbanization (Stewart, 1982, and Stewart, 1984). The reader is simply cautioned that the period of record can make a noticeable difference, and the data in Tables 5 and 6 are recent.

III. PRECIPITATION, CLOUDS, AND SOLAR RADIATION

Precipitation in Honduras is normally in liquid form (Portig, 1965). Hail is only expected to occur from one to three times a year at any given station (Frisby, 1966; Frisby and Sansom, 1967). Snow has not been reported in Honduras (Portig, 1965).

The amounts of rainfall at a station vary considerably from one year to the next. A good example is Tegucigalpa where monthly and annual mean rainfalls for the period 1938 through 1960 can be obtained by combining records from Johannessen (1959) and Environmental Science Services Administration (1966). The lowest mean annual rainfall from this period is the 24.96 inches for 1950, and the highest is 54.87 inches for 1945. Five of the 23 years received less than 30.00 inches and five received more than 45.00 inches. Monthly means fluctuate even more. Two and 52/100 inches of rain were recorded at Tegucigalpa in January 1945, but the values were 0.00 and 0.01 in January 1940 and 1955, respectively. Amounts may also vary by more than an order of magnitude in the wetter summer months. Fluctuations of monthly means are also large at other mountainous stations and at coastal stations even though the available periods of record are shorter.

In addition to the large year-to-year fluctuations of the amount of rainfall for any given location, the mean annual rainfall varies considerably throughout Honduras. Figure 2 is a map of mean annual rainfall based on data from Portig (1965), Wernstedt (1972), and Johannessen (1959). Mean annual rainfalls are at least 100 inches along most of the northern coast of Honduras. Very large mean annual precipitation from 120 to more than 150 inches occurs near 88° W and 15° N. Mean annual rainfall along the Pacific coast is near 80 inches. In other parts of the country mean annual rainfall is smaller, and at a few stations less than 40 inches falls annually.

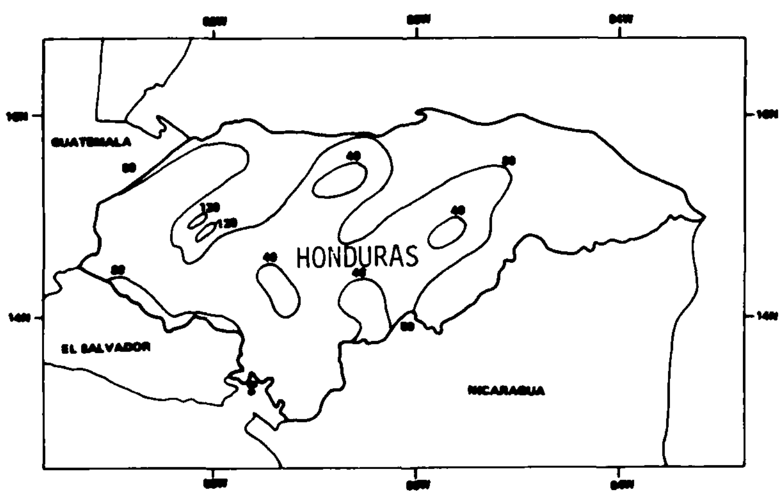

Figure 2. Mean annual rainfall in inches.

Mean annual rainfall is not influenced by elevation in a simple or straightforward way. The station with the highest mean annual rainfall (152.52 inches, based on 13 years of data) among Wernstedt's (1972) sixty stations is at 88°05'W and 14°51'N and has an elevation of 2131 feet (650m).

This might seem consistent with Hastenrath's (1967) study of the Guatemalan highlands where the largest rains occurred at elevations between 600 and 1100m. However, 13 years of data produced an average of only 26.10 inches at an elevation of 2020 feet at 14°08'N and 86°53'W. At 14°17'N and 87°40'W the mean annual rainfall was 39.02 inches at an elevation of 2187 feet based on 10 years of data. There is also a lot of scatter in the data at lower elevations. Mean annual rainfalls greater than 80 inches do not occur above 3000 feet according to available data.

There is evidence that the height of an observing station relative to the surrounding land is much more important than the absolute elevation. Dry valleys are typically surrounded by well watered mountains in Central America (Rumney, 1968). The distribution of rain gages in Honduras is not adequate to prove this, but the distribution of vegetation supports the belief that precipitation is greater at higher elevations which surround dry valleys in Honduras (Rumney, 1968; Hastenrath, 1967; Johannessen, 1959).

Hurricanes are not common in Honduras. Only 14 hurricanes passed over or close to the north coast during the period 1874-1942, and only three hurricanes entered the interior during this period (Johannessen, 1959).

The seasonal variation of rain is large at a majority of Honduran stations. The only exception is in a very small area along the Caribbean coast in the extreme west where the rainy season is poorly defined (Gramzow and Henry, 1972). Gramzow and Henry examined five-day periods to determine when the rainy season begins and ends. The rainy season begins some time in May in the southern and eastern parts of Honduras, but it starts in June or July along the western half of the Carribbean coast. The rainy season ends at some time during the period October through January. Most of the area has a double maximum during the rainy season, but the summer minimum is not deep like the minimum during the dry season. However, Johannessen (1959) found that the summer dry spell in the interior allowed unsurfaced roads to become passable by truck or jeep traffic. During much of the rainy season these roads become strips of mud with pools of muddy water, and even travel on horseback or with carts pulled by oxen is difficult.

Figure 3 illustrates the typical double maximum at three stations in Honduras. The graphs were plotted from monthly mean tabular data in Wernstedt (1972). Tegucigalpa (14°03'N, 87°13'W) is an interior valley station, and Amapala (13°17'N, 87°39'W) is on an island just off the Pacific coast. Both stations are very dry in the winter, and each monthly mean is considerably less than one inch from December through March. Puerto Lempira (15°13'N,83°47'W) is located on the far eastern part of the Caribbean coast. It has a minimum monthly rainfall of 2.36 inches which occurs in March. All three stations have one maximum in June. The June rainfall is 6.46 inches at Tegucigalpa and a little more than twice as much as this at the other two stations. Amapala and Tegucigalpa have another maximum in September which is the wettest month at both stations. The September averages at Tegucigalpa and Amapala are 7.17 and 19.33 inches, respectively. The second maximum at Puerto Lempira is the 16.02 inches which occurs in October, and the rainy season extends through January. The less rainy months in the middle of the rainy season at Amapala and Puerto Lempira are wetter than the wettest month at Tegucigalpa. The driest summer month at Tegucigalpa is July which receives an average of only 3.46 inches of rain.

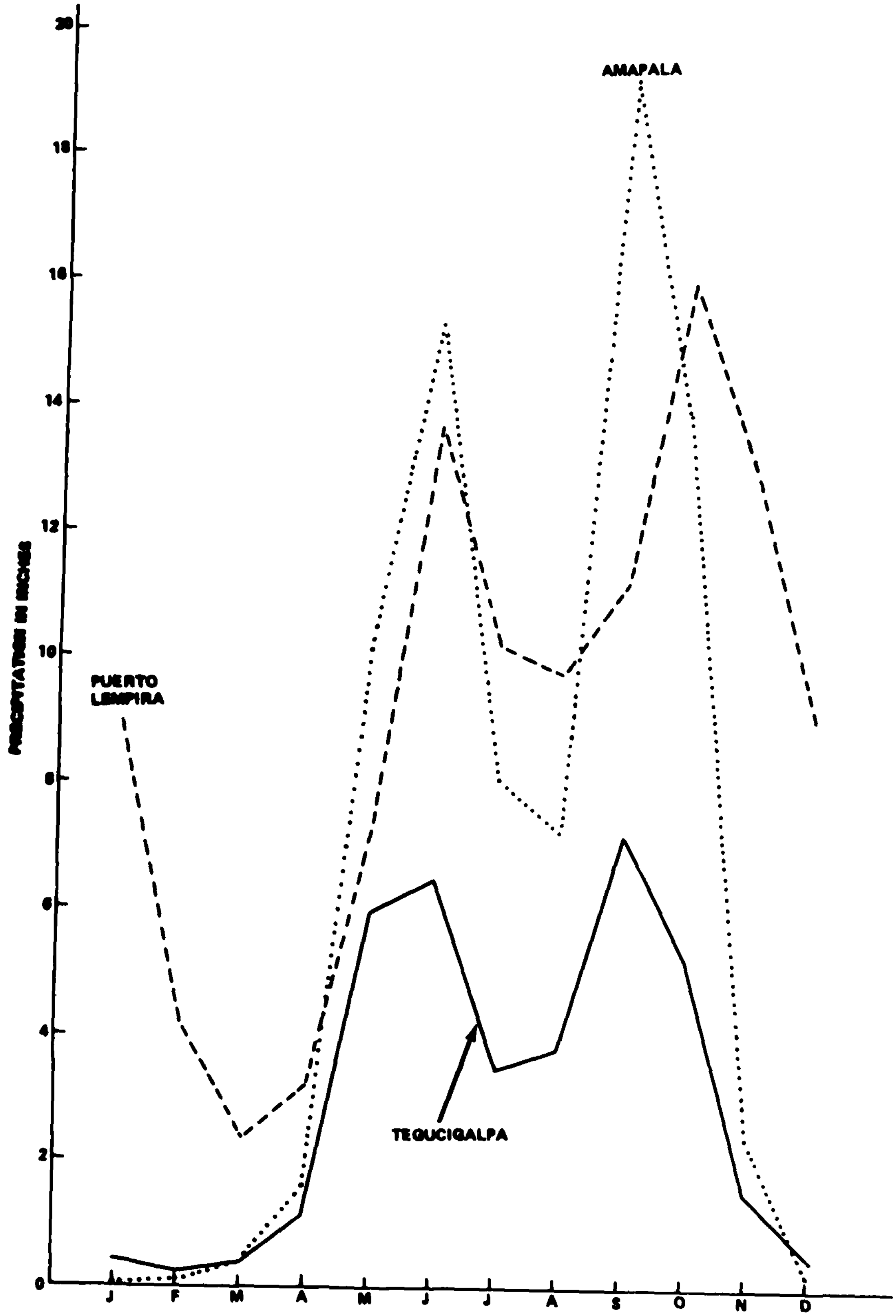

Figure 3. Typical rainfall pattern with a double maximum.

Figure 4 contains two stations on the western portion of the Caribbean coast. These stations do not have any excessively dry months. The driest month at La Ceiba (15°47'N, 86°50'W) is May which has a mean rainfall of 3.66 inches. The least rainfall at Puerto Cortés (15°48'N, 87°56'W) is the 4.25 inches which occurs in April. Mean monthly rainfall is above 10 inches during each month from October through January at both stations. Puerto Cortes shows no indication of a double maximum. Its one maximum is the 19.41 inches which falls in October. La Ceiba has a relative minimum of 11.26 inches in November between the 15.24 inches in October and 16.54 inches in December. The lack of a minimum in the middle of the summer and the early winter maximum at these two stations is consistent with the discussion of Garcia et al. (1978). They state that this pattern is typical of many northern and eastern coastal areas in the region which includes Central America, northern South America, and large islands such as Cuba.

Rainfall in winter is commonly associated with "northers." These are north winds associated with the incursion of middle latitude fronts into low latitudes. In winter the interaction of middle latitude and tropical circulations may be quite intense (Bosart, 1973), and winds are sometimes destructive (Rumney, 1968). Di Mego et al. (1976) have examined frontal incursions into this region during the period 1965-1972. Mean values which were read from their maps are included in Table 8. Klaus (1973) examined the period 1899-1960 and tabulated the number of frontal invasions in different regions for each month of each year. Only 11 months of data are missing for the region which includes Honduras. Maximum, minimum, and mean values from Klaus are also included in Table 8. Because the area which includes Honduras in Klaus (1973) is larger than Honduras, it is not surprising that the mean numbers of frontal incursions from Klaus in Table 8 are larger than those estimated for Honduras from maps by Di Mego et al. (1976). The biggest differences are in the warmer part of the year when the intensity of these frontal zones is not so strong anyway.

Along the southern coast of Honduras much of the rain in the summer is associated with systems known as "temporales" (Portig, 1965; Hastenrath, 1967). These atmospheric disturbances originate over the Pacific Ocean. The rainfall comes from a thick and extended cover of nimbostratus clouds and is of moderate intensity.

Summer rainfall normally comes in showers over most of Honduras. These may be associated with easterly waves, or they may be relatively isolated convective showers. Johannessen (1959) describes a typical summer day in the central part of Honduras. Skies begin to cloud up in the early afternoon, and rain begins to fall when they become deep enough. The temperature drops 8-10°F with the arrival of rain. The rain lasts about 15 minutes, and then temperatures return almost to their former values.

There is disagreement as to how much of the rain is accompanied by thunder. The US Air Weather Service (1968) only records a mean of 4.7 thunderstorms annually at Toncotin International Airport at Tegucigalpa. Portig (1965) states that thunderstorms are common in the rainy season at Tegucigalpa, and this agrees with the discussion of Johannessen (1959). Portig even states that more than one thunderstorm occurs on many days at Tegucigalpa. Portig also states that thunderstorms occur in large numbers in the Gulf of Fonseca. Finally, even the US Air Weather Service reports 55.5 mean annual thunderstorm days at Tela.

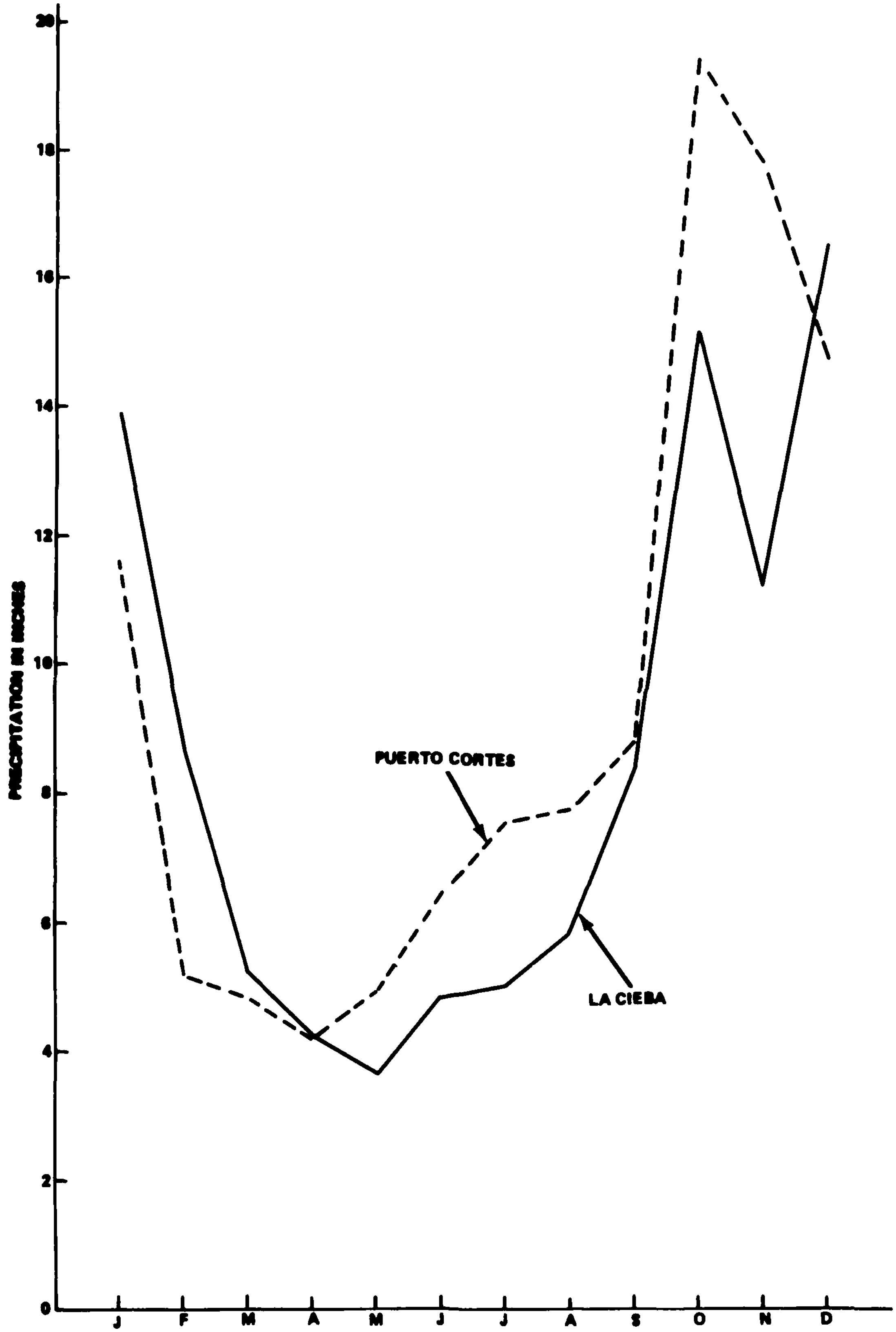

Figure 4. Rainfall variation on western Caribbean coast.

Knowledge of solar radiation in Honduras is very small in comparison with available information about precipitation, but an overall average of the amount of solar radiation has been obtained for each month. A note of caution is in order before this information is discussed. Atwater and Ball's (1978) data contain differences of 15 to 30 percent for monthly total solar radiations within distances of 200 km in the United States. Suckling's (1983) more recent data show that daily totals can be extrapolated less than 15 percent as far as monthly totals. Powell's (1983) investigation also reveals that statistically significant differences can exist between periods of record which do not use the same type of measuring instrument.

Table 9 contains surface radiation data based on worldwide maps from Löf et al. (1966) and DeJong (1973). The scale of the maps is small, and the analysis is obviously smoothed. Therefore, only one average value for all of Honduras is given for each month. These are daily means of total solar radiation (direct plus diffuse) incident upon a horizontal surface. The annual average amount of radiation reaching the earth is approximately 450 calories per square centimeter per day. Variation throughout the year depends upon the amount and type of clouds (Myers and Dale, 1983; Puffer, 1975), and upon the amount of radiation which reaches the top of the atmosphere (Hess, 1959; List, 1958). The amount of radiation reaching the top of the atmosphere in Table 9 is based on interpolations for 15° N from Table 132 of List (1958). One sees that radiation reaching the top of the atmosphere is larger during the period which is the rainy season at most stations than during the dry season. Values are more than 900 cal cm^{-2} day^{-1} in May, June, and July, and 895 cal cm^{-2} day^{-1} reach the top of the atmosphere in April and August. The minimum reaching the top of the atmosphere is the 675 cal cm^{-2} day^{-1} in December, and 410 cal cm^{-2} day^{-1} reach the earth in December. In June 400 cal cm^{-2} day^{-1} reach the earth even though it is much rainier than December in most of Honduras. The largest amount of radiation reaches the earth in March which is relatively dry at most stations. The last row in Table 9 is the difference between the amount of radiation which reaches the top of the atmosphere and the amount which reaches the surface of the earth. This difference should be largest when the average amount of cloudiness is largest. The largest difference is in June which has a relative maximum of rainfall at the majority of Honduran stations (Wernstedt, 1972), and at some stations the rainfall in June is an absolute maximum. The minimum difference is in November which is during the dry season in most of Honduras. Furthermore, even stations which are not really dry may have a relative minimum such as the one La Cieba has (see Figure 4). Therefore, the solar radiation data have a general average validity in spite of the limitations.

Seasonal variations of cloud amounts for the period 1973-1981 at Tela and Tegucigalpa are given in Tables 10 and 11. Code numbers 1 through 8 are cloud amounts in octas, and code number 9 indicates that the sky is obscured. Cloud codes are greater than or equal to 5 more than one-third of the time at all hours in all seasons at both Tela and Tegucigalpa. During the day in summer and fall more than two-thirds of the observations are within the 5-9 range at both stations. At Tegucigalpa in the summer in the afternoon more than nine-tenths are greater than or equal to 5. Most of the observations of clear skies occur in winter and spring, and they are more common at night than during the day. Clear skies occur less than one-fourth of the time even in the winter and spring at night. Overcast and obscured skies are also more common at night than during the day at both stations, and this difference exists throughout the year.

IV. VISIBILITY

Available evidence indicates that lowest visibilities in Honduras are expected in spring. This is clearly shown in Tables 12 and 13 for the period 1973-1981 at Tela and Tegucigalpa. The first column in each table contains the percent of time that visibility is less than or equal to 1 km (0.62 miles) which is the criterion for the existence of fog. Spring is the season of the most frequent occurrence of fog at both Tela and Tegucigalpa. Fog is more common at Tela than at Tegucigalpa throughout the day in all seasons. For example, in spring at 0600 hours fog occurs 8.9 percent of the time at Tela and 3.0 percent of the time at Tegucigalpa. These results are consistent with a publication by the US Air Weather Service (1968) which lists the number of days with visibility less than one-half mile for each month at Tela based on a four-year period. April has 2.9 days and every other month 0.0 days with these low visibilities. Spring also has the largest percent of low visibilities if another threshold is considered in Tables 12 and 13. For example, approximately half of visibilities at Tela are equal to or below 10 miles in spring, but less than one-third of visibilities are this low during most hours in the other seasons. At 0000, 1200, and 1800 hours at Tegucigalpa there are also a much larger percent of visibilities equal to or less than 10 miles in spring, but at 0600 hours spring, summer, and fall all have between 45 and 50 percent of visibilities equal to or less than 10 miles. Winter has very high visibilities at Tegucigalpa. At 0600 hours 73.5 percent of visibilities are greater than 10 miles at Tegucigalpa, and at other hours visibilities are even better.

A thorough literature search did not produce frequency distributions of visibility in Honduras, and therefore information from neighboring El Salvador has been examined. Hastenrath (1963a) studied data from Ilopango Airport (13° 42'N, 89°07'W, 615m) near San Salvador. Fog almost never occurs from October through March and it exists only one percent of the time from April through September. Even visibilities less than or equal to 5 km (3.1 miles) are rare from October through February. April has 15 percent of visibilities less than or equal to 5 km. This high portion of low visibilities coincides with the last part of the dry season. In April 40 percent of visibilities are less than or equal to 10 km (6.21 miles). No other month has more than 12 percent of visibilities less than or equal to 10 km. Visibilities greater than 80 km (49.7 miles) occur 24 percent of the time in October and December, and these large visibilities occur at least 9 percent of the time from October through February. Visibilities greater than 80 km are uncommon from March through September at Ilopango Airport.

Tables 14 and 15 are contingency tables which show the relationship between visibility and cloud amount at Tela and Tegucigalpa. When visibilities are greater than 10 miles at these stations, overcast and obscured skies are only half as likely as they are when all visibilities are combined. When visibilities are between 0.62 and 5 miles, the probability of overcast and obscured skies is more than three times as large as when all visibilities are combined. Thus, at Tela 52.4 percent of the observations with visibility between 0.62 and 5 miles are in the cloud category 8-9, but only 14.8 percent of all observations are in this cloud category. Because more than two-thirds of all visibilities are greater than 10 miles at Tela and Tegucigalpa, the inverse relationship between visibility and cloud amount does not mean that the probability of good visibility with overcast and obscured skies is negligible. If the cloud amount is 8 or 9 at Tela, the probability that the visibility is greater than 10 miles is 26.6 percent, and at Tegucigalpa it is 30.4 percent. More than one-half of all observations simultaneously have more than 50 percent cloud cover and more than 5 miles visibility.

V. WIND

This section includes discussions of wind speed at Tela, Tegucigalpa, Swan Island, and two marine areas. Wind speeds are related to wave heights in the marine areas.

Table 16 contains seasonal mean wind speeds for the hours 0000, 0600, 1200, and 1800 at Tela and Tegucigalpa. Weakest winds occur at 0600 hours at both stations. Strongest winds occur at 1200 or 1800 hours, and speeds are approximately equal at these two hours except in fall when the wind at 1200 hours is definitely stronger than the wind at 1800 hours. The winds at noon are more than four times as large as the very weak winds at 0600 hours in all seasons at Tela. Strongest winds at Tela occur in the summer, but they are almost as strong in spring. Winds are stronger at Tegucigalpa than at Tela throughout the day throughout the year. The difference is small in the summer afternoon. At 1800 hours the mean wind in summer is 3.6 m/sec at Tela and 3.8 m/sec at Tegucigalpa. Strongest winds at Tegucigalpa occur in winter when the mean speed is 4.8 m/sec at 1200 hours.

Table 17 contains data from the US Air Weather Service (1968) for Tela. The annual average portion of the time that wind speeds are greater than or equal to 17 knots (8.74 m/sec) is only 1.6 percent. These speeds are most frequent in February and March when they occur more than four percent of the time. Speeds greater than or equal to 28 knots (14.40 m/sec) occur at least one percent of the time in February and March, but the annual average is only 0.4 percent.

Detailed information on wind speeds at Swan Island were readily available from previous studies such as Essenwanger and Stewart (1983) and Stewart and Essenwanger (1978). Table 18 contains monthly frequency distributions of wind speed at Swan Island. Maximum wind speeds are 15 m/sec in February and March, but they are 13 m/sec or less in the remaining 10 months. Maximum speeds are either 10 or 11 in each month from April through August. In all months minimum speeds are 0, and means are greater than medians. The lowest monthly mean speed is the 4.4 m/sec which occurs in October, and the highest is the 6.0 m/sec in March.

Table 19 is a contingency table which relates wind speed and wave height for the Caribbean area which extends north from Honduras and is centered near British Honduras. The annual average percentages in Table 19 were obtained from marine surface observations by the Naval Weather Service Command (1974). Because all numbers are rounded, the row and column sums are not always equal to the sum of the numbers as given in the table. Large speeds are associated with high waves. Observations with winds in the speed category 34-47 knots have wave heights of 12 feet. Speeds greater than 47 knots occur less than 0.1 percent of the time if they occur at all, and each wave height category greater than 12 feet occurs 0.0 percent of the time. Waves from 0 to 4 feet are expected with winds from 0 to 3 knots (1 knot = 0.5144 m/sec). Speeds in the category 11-21 knots can be associated with waves in all categories from 0 through 12 feet, but most coincide with wave heights from 3 to 6 feet. More than two-thirds of all wave heights are less than or equal to 4 feet, and more than 99 percent are below 10 feet. More than 95 percent of wind speeds are less than 22 knots. Therefore, the maritime area north of Honduras typically has low waves and low speeds.

Table 20 contains annual average percentages of observations in a contingency table of wind speed and wave height for an area of the Pacific Ocean which includes the south coast of Honduras. The center of the region is south of Honduras and is off the Nicaraguan coast (Naval Oceanography Command Detachment, 1981). Wave heights are expected to be less than or equal to 16 feet, and speeds are normally less than or equal to 47 feet. Average wind speeds and wave heights are lower than they are north of Honduras.

VI. SUMMARY AND CONCLUSIONS

The terrain of Honduras is quite rugged, and consequently the climate is not uniform. The coastal areas generally have wet, tropical climates, and cooler and drier conditions prevail in the mountainous interior where elevations reach nearly 3 km. The highest observing station is just below 2 km.

Both temperature and absolute humidity are higher near the coast than in the mountainous part of the country. Mean annual temperature at Tela is near 78°F and that at Tegucigalpa is near 71°F. Mean annual absolute humidity is approximately 20 g/m^3 at Tela and 13 g/m^3 at Tegucigalpa. Mean diurnal variation of absolute humidity is less than 2.0 g/m^3 at both stations, and the seasonal variation is larger with a minimum in winter and a maximum in summer. Diurnal variation of temperature is approximately 15°F at Tela and a few degrees more at Tegucigalpa. Differences between the warmest and coolest month are less than 10°F at stations throughout Honduras. Highest temperatures occur in the spring in the mountainous areas, but summer may be slightly warmer at coastal stations such as Tela.

Visibilities in Honduras are lowest in spring, and fog is most common at 0600 hours. In spring at 0600 hours fog occurs 8.9 percent of the time at Tela and 3.0 percent at Tegucigalpa. Only about half of visibilities are greater than 10 miles throughout the day in spring at Tela, but more than two-thirds exceed 10 miles during most hours in other seasons. At Tegucigalpa 73.5 percent of visibilities exceed 10 miles at 0600 hours in winter, but only slightly more than half of visibilities are this large at this hour in other seasons. At 0000, 1200, and 1800 hours at Tegucigalpa visibilities are worst in spring. Visibilities at Tegucigalpa are particularly good at noon in winter when 89.2 percent are greater than 10 miles.

There is some tendency for low visibility to be associated with large cloud amount in annual summaries of all individual observations for Tela and Tegucigalpa. This is consistent with the fact that skies are more likely to be overcast or obscured at 0600 hours than at 1200 hours in all seasons at both stations while lower visibilities occur at 0600 hours. However, the relationship is not very reliable when seasons are compared. Overcast skies are much more common in fall than in spring which is the season of lowest visibilities. Spring is also the season with the largest percentage of clear skies.

The low cloud amounts in spring coincide with the season during which maximum amounts of solar radiation reach the earth in Honduras. The annual average is approximately 450 cal cm^{-2} day^{-1} for all of Honduras. The means are 540, 505, and 470 cal cm^{-2} day in the spring months of March, April, and May, respectively. During November and February approximately 470 cal cm^{-2} day^{-1} reach the earth. The solar radiation which reaches the earth during the remaining seven months is below average. The minimum is the 400cal cm^{-2} day^{-1} which occurs in June in spite of the fact that more solar radiation reaches the top of the atmosphere in June than in March or April.

The annual variation of the receipt of solar radiation at the surface is related to the overall average variation of precipitation which never falls as snow. The typical pattern of rainfall in Honduras has two maxima in the warmest part of the year. This pattern prevails along ths south coast, in the mountainous interior, and along the far eastern part of the Caribbean coast. The first maximum occurs in June and the second in September or October. The summer minimum is not as dry as the minimum during the cooler part of the year. Monthly means less than one inch often occur from December through March in the mountainous interior and along the Pacific coast. The rainy season extends through January along the far eastern Caribbean coast, and the driest month has at least two inches of rain. Along the central and western part of the Caribbean coast the driest month typically has more than three inches of rain, and it may occur as late as May. A maximum does not normally occur before October in the western part of the Caribbean coast, and there may be only one maximum. In the extreme western part of the Caribbean coast the rainy season may not be well defined. Mean annual rainfalls are at least 100 inches along most of the northern coast of Honduras. Mean annual rainfall along the southern coast is near 80 inches. At some stations in the interior the annual average is less than 40 inches. This spatial variation in the interior is not easily explained. The annual rainfall varies considerably from one year to the next. For example, during a 23-year period at Tegucigalpa the lowest annual rainfall was 24.96 inches and the highest was 54.87 inches. Fluctuations of monthly means are even larger. Coastal stations also show large year-to-year fluctuations of amount of rainfall.

The final variable which is examined in this report is wind speed. Mean winds are strongest in winter at Tegucigalpa, in spring at Swan Island, and in summer at Tela, according to our data. Mean winds in summer and spring are not much different at Tela, and there is evidence in the work of others that maximum speeds occur in spring at Tela during the periods of record which they used. The lowest monthly mean speed at Swan Island is the 4.4 m/sec in October and the highest is 6.0 m/sec in March. Speeds are lower at Tela and Tegucigalpa where diurnal variations were examined. Minimum speeds at these stations occur near daybreak, and maxima are in the afternoon. Highest mean speeds at Tegucigalpa for any time of day are near 5 m/sec, and those at Tela are below 4 m/sec. Finally, marine areas off both coasts were considered to compare wind speed with wave height. Ninety-five percent of the waves are below six feet in the Pacific, and 92 percent are below six feet in the Caribbean. Higher speeds tend to be associated with higher waves. Speeds greater than 48 knots (24.7 m/sec) occur less than 0.1 percent of the time in both areas.

TABLE 1. Mean Temperatures in Degrees Fahrenheit at Representative Honduran Stations

Station	Lat	Long	Elev (ft)	Annual	Month											
					J	F	M	A	M	J	J	A	S	O	N	D
Amapala	13°17'N	87°39'W	16	83.8	83.5	84.0	85.8	86.5	84.9	82.6	84.0	84.2	82.0	81.7	82.2	83.1
Choluteca	13°18'N	87°12'W	157	83.1	83.3	83.3	86.0	86.4	84.7	81.0	83.3	82.9	81.1	80.4	81.1	82.8
Guanaja	16°28'N	85°54'W	6	80.8	77.5	78.4	79.5	81.7	79.9	83.1	82.2	83.3	83.8	81.3	79.9	78.1
San Pedro Sula	15°28'N	88°01'W	249	78.8	73.8	75.6	78.8	81.1	82.2	82.2	80.8	81.5	81.5	78.4	76.3	74.1
La Ceiba	15°47'N	86°50'W	26	78.3	74.8	75.0	77.9	79.0	80.4	81.1	81.1	81.7	81.5	78.6	76.5	75.7
Tela	15°43'N	87°29'W	41	77.9	73.8	74.5	76.5	79.0	79.9	81.1	80.2	79.9	80.8	78.6	75.9	74.3
La Mesa	15°27'N	87°56'W	85	77.9	73.2	74.1	76.5	79.3	80.6	80.6	79.7	80.4	80.4	78.1	75.4	74.7
Comayagua	14°25'N	87°38'W		76.1	70.9	73.4	76.1	77.9	79.7	77.9	78.1	78.6	77.4	76.6	74.7	74.7
Catacamas	14°54'N	85°56'W	1449	75.9	71.8	73.8	76.5	78.6	79.3	77.7	76.3	76.5	77.4	76.3	74.1	72.5
Yoro	15°10'N	87°07'W	2000	75.9	71.8	73.6	78.1	79.3	79.5	78.6	76.5	76.6	74.7	74.3	74.3	72.0
Nuevo Ocotepeque	14°26'N	89°10'W	2601	75.7	72.3	73.6	77.4	79.0	77.9	76.6	75.9	77.2	75.7	74.8	72.9	71.8
El Zamorano	14°00'N	87°02'W	2601	71.8	68.9	69.8	72.3	74.1	75.2	73.0	72.3	72.9	72.9	72.0	70.3	68.9
Tegucigalpa	14°03'N	87°13'W	3302	71.1	67.1	69.1	71.2	73.8	74.3	74.1	72.5	72.9	73.2	71.4	69.4	67.6
Santa Rosa de Copán	14°47'N	88°46'W	3543	68.0	63.1	64.9	67.6	70.7	71.1	70.9	70.0	70.3	70.3	67.8	65.3	63.3
La Esperanza	14°16'N	88°10'W	6494	63.8	57.8	60.1	63.3	65.6	65.3	66.1	64.7	65.4	64.7	65.6	62.2	57.6

(Wernstedt, 1972; Rudloff, 1981; Environ. Science Svcs. Admin., 1966)

TABLE 2. Absolute Maximum and Minimum Temperatures in Degrees Fahrenheit

Location	Source	Absolute Maximum	Absolute Minimum
North Coastal Stations			
Guanaja	Johannessen	96.0	58.0
La Ceiba	Johannessen	93.0	41.0
Tela	Johannessen	95.0	57.0
Tela	US Air Wea Ser	96	58
Tela	DRSMI-RRA	102.6	28.4*
San Pedro Sula	Johannessen	106.0	49.6
Interior Valley Stations			
Catacamas	Johannessen	103.0	39.0
Telica	Johannessen	100.4	52.7
Comayagua	Johannessen	101.0	39.0
Villa de San Antonio	Johannessen	102.0	42.8
Tegucigalpa (airport)	Johannessen	96.0	39.1
Tegucigalpa (airport)	US Air Wea Ser	92	35
Tegucigalpa (city)	Johannessen	96.8	44.0
Tegucigalpa	Showers	93	44
Tegucigalpa	DRSMI-RRA	104.4	21.2*
Yoro	Johannessen	103.0	51.0
South Coastal Stations			
Nacaome	Johannessen	104.0	62.0

* These minimum temperatures are based on data which were examined carefully. They appear to be correct even though they are much lower than those found in previous records.

TABLE 3. Maximum and Minimum Temperatures, Dew Point Depression, and Absolute and Relative Humidities at Toncotin Int'l (14°03'N, 87°13'W) at Tegucigalpa.

Meteorological Variable	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Absolute maximum temperature (°F)	87	90	92	92	91	90	87	88	89	86	86	88
* Mean maximum temperature (°F)	78	81	82	88	91	85	85	87	87	86	84	84
* Mean minimum temperature (°F)	43	40	41	50	54	58	52	51	53	53	66	48
Absolute minimum temperature (°F)	39	40	35	41	41	48	50	51	39	48	48	47
Mean dew point (°F)	51	48	47	54	61	64	61	60	63	63	67	58
Mean dew point depression (°F)	9	12	14	15	11	8	7	9	7	7	8	8
Estimated mean absolute humidity (g/m^3)	9.8	8.8	8.4	10.8	13.7	15.2	13.7	13.3	14.6	14.6	16.7	12.4
Mean relative humidity (percent)	74	68	63	63	70	79	78	76	80	81	79	77

* The mean maxima (minima) have been calculated from the highest (lowest) observed value per month over the period of record. Data taken or estimated from US Naval Weather Service World-Wide Airfield summaries which were prepared by the US Air Weather Service.

TABLE 4. Maximum and Minimum Temperatures, Dew Point Depression, and Absolute and Relative Humidities at Tela (15°46'N, 87°27'W) on the North Coast of Honduras.

Meteorological Variable	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Absolute maximum temperature (°F)	87	93	92	96	94	93	91	92	92	93	92	88
*Mean maximum temperature (°F)	82	82	85	87	88	89	83	88	90	86	84	82
*Mean minimum temperature (°F)	67	67	69	72	74	74	73	73	74	71	70	68
Absolute minimum temperature (°F)	60	58	63	66	66	62	70	68	71	60	64	60
Mean dew point (°F)	68	68	70	74	75	75	75	75	75	73	71	71
Mean dew point depression (°F)	6	6	7	6	6	6	5	5	7	6	6	4
Estimated mean absolute humidity (g/m^3)	17.3	17.3	18.4	20.9	21.7	21.7	21.7	21.7	21.7	20.3	19.1	19.1
Mean relative humidity (percent)	84	83	81	83	83	83	83	84	83	85	86	87

* The mean maxima (minima) have been calculated from the highest (lowest) observed value per month over the period of record. Data taken or estimated from US Naval Weather Service World-Wide Airfield summaries which were prepared by the US Air Weather Service.

TABLE 5. Seasonal and Diurnal Variation of Temperature and Absolute Humidity at Tela for the Years 1973-1981.

Variable	Hour	Season			
		Winter	Spring	Summer	Fall
Temperature (^{o}F)	0000	72.0	76.6	77.7	75.1
	0600	69.7	73.4	75.3	73.7
	0900	74.7	79.9	81.1	78.8
	1200	79.3	85.2	86.5	82.9
	1500	79.8	85.9	86.6	82.7
	1800	76.7	82.3	83.3	79.5
	2100	73.2	78.7	80.3	76.7
Absolute Humidity (g/m^3)	0000	17.8	20.0	21.0	19.7
	0600	16.7	18.5	19.7	18.8
	0900	18.0	19.5	21.0	19.8
	1200	18.5	20.4	21.6	20.6
	1500	18.6	20.6	21.4	21.0
	1800	18.4	20.2	21.2	20.3
	2100	18.1	20.1	21.0	20.1

TABLE 6. Seasonal and Diurnal Variation of Temperature and Absolute Humidity at Tegucigalpa for the Years 1973-1981.

Variable	Hour	Season			
		Winter	Spring	Summer	Fall
Temperature					
(°F)	0000	64.3	70.2	69.2	67.7
	0600	60.9	65.1	66.8	65.7
	0900	65.5	71.9	71.4	70.1
	1200	73.0	79.5	77.3	76.0
	1500	76.6	83.1	80.3	78.2
	1800	73.7	80.0	77.3	74.9
	2100	67.9	73.9	71.8	70.0
Absolute Humidity					
(g/m^3)	0000	12.0	13.0	14.4	14.3
	0600	11.6	12.8	14.3	14.0
	0900	11.6	12.7	14.2	14.1
	1200	11.4	11.9	13.6	13.7
	1500	11.2	11.4	13.3	13.8
	1800	11.5	11.9	13.7	14.1
	2100	11.9	12.8	14.2	14.4

TABLE 7. Seasonal and Diurnal Variation of Temperature and Absolute Humidity at San Salvador Computed from Hastenrath (1963b).

Variable	Hour	Season			
		Winter	Spring	Summer	Fall
Temperature					
(^{o}F)	0000	66	69	68	68
	0600	63	67	67	66
	0900	74	78	77	76
	1200	81	85	82	81
	1500	83	84	82	80
	1800	74	76	75	72
	2100	69	71	71	70
Absolute Humidity					
(g/m^3)	0000	12.5	14.9	16.1	15.2
	0600	11.9	14.4	15.9	14.8
	0900	12.7	15.2	17.0	16.3
	1200	12.2	14.5	16.9	16.3
	1500	12.1	15.6	16.9	16.2
	1800	13.1	16.2	17.4	16.3
	2100	12.7	15.3	16.7	15.8

TABLE 8. Frontal Incursions into the Area of Honduras

SOURCE	VARIABLE	MONTH J	F	M	A	M	J	J	A	S	O	N	D
DiMego et al. (1976)	Mean	2.0	2.2	1.6	0.9	0.1	0.1	0.0	0.0	0.0	0.5	1.5	2.0
Klaus (1973)	Maximum	9	8	8	7	9	2	1	0	5	7	7	9
	Mean	2.7	2.1	2.4	1.7	1.1	0.2	0.0	0.0	0.2	1.6	2.5	2.9
	Minimum	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 9. Average Solar Radiation for Honduras in Calories Per Square Centimeter Per Day.

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Solar Radiation												
Top of Atmosphere	700	770	850	895	908	904	903	895	860	800	715	675
Surface of Earth	425	470	540	505	470	400	430	430	440	420	470	410
Top Minus Surface	275	300	310	390	438	504	473	465	420	380	245	265

TABLE 10. Cloud Amounts at Tela, Honduras.

Season	Hour	Cloud Amount 0	1-4	5-7	8-9
Winter	0000	16.4	33.3	28.7	21.6
	0600	9.0	44.4	27.8	18.8
	0900	6.9	43.9	33.0	16.2
	1200	3.2	49.6	32.6	14.6
	1500	0.5	48.0	38.3	13.2
	1800	2.4	40.8	42.7	14.1
	2100	11.7	38.3	32.2	17.8
Spring	0000	18.4	39.8	30.6	11.2
	0600	11.7	37.2	37.8	13.3
	0900	13.7	39.6	35.5	11.2
	1200	11.7	44.6	34.7	9.0
	1500	10.6	42.8	39.2	7.4
	1800	9.3	40.0	41.9	8.8
	2100	18.0	44.2	27.0	10.8
Summer	0000	3.3	40.0	42.0	14.7
	0600	1.7	24.3	63.6	10.4
	0900	0.7	25.6	66.7	7.0
	1200	0.4	32.0	61.1	6.5
	1500	0.0	24.5	67.8	7.7
	1800	0.0	13.1	74.6	12.3
	2100	0.0	26.3	55.8	17.9
Fall	0000	2.3	33.9	37.3	26.5
	0600	1.5	20.1	56.2	22.2
	0900	0.9	24.6	55.4	19.1
	1200	0.3	25.9	57.8	16.0
	1500	0.0	21.4	63.0	15.6
	1800	0.0	17.5	61.7	20.8
	2100	1.5	30.1	40.3	28.1

Note: Codes 1 through 8 are cloud amounts in octas, and code 9 indicates that the sky is obscured.

TABLE 11. Cloud Amounts at Tegucigalpa, Honduras.

Season	Hour	Cloud Amount			
		0	1-4	5-7	8-9
Winter	0000	14.9	38.6	38.3	8.2
	0600	3.0	42.1	47.1	7.8
	0900	1.5	43.2	51.3	4.0
	1200	0.9	43.6	53.0	2.5
	1500	0.9	39.3	58.1	1.7
	1800	1.1	44.5	50.8	3.6
	2100	16.5	40.8	38.4	4.3
Spring	0000	21.0	32.2	33.0	13.8
	0600	2.8	43.1	46.1	8.0
	0900	2.5	45.8	45.6	6.1
	1200	[illegible]	43.6	50.7	4.1
	1500	1.1	34.2	60.9	3.8
	1800	1.5	37.3	52.3	8.9
	2100	18.8	35.5	33.0	12.7
Summer	0000	2.1	26.6	49.9	21.4
	0600	0.6	14.9	71.3	13.2
	0900	0.0	11.9	79.7	8.4
	1200	0.0	10.3	83.3	6.4
	1500	0.0	9.4	86.2	4.4
	1800	0.0	9.7	80.4	9.9
	2100	1.5	21.1	53.1	24.3
Fall	0000	2.7	22.0	50.2	25.1
	0600	0.4	18.5	64.4	16.7
	0900	0.0	19.1	74.7	6.2
	1200	0.0	13.5	81.9	4.6
	1500	0.0	9.6	86.6	3.8
	1800	0.0	13.4	75.4	11.2
	2100	2.1	22.9	50.5	24.5

Note: Codes 1 through 8 are cloud amounts in octas, and code 9 indicates that the sky is obscured.

TABLE 12. Cumulative Percent of Visibilities Less Than or Equal to Threshold Values at Tela for 1973-1981.

Season	Hour	Visibility Threshold (miles)					
		≤0.62	≤1	≤2	≤3	≤5	≤10
Winter	0000	1.5	2.1	5.6	6.2	13.3	28.2
	0600	2.3	2.3	5.6	7.1	10.9	22.9
	1200	0.8	0.8	4.2	5.3	10.1	21.8
	1800	1.2	1.2	3.6	4.8	9.0	23.1
Spring	0000	4.1	4.1	5.1	6.1	19.4	44.9
	0600	8.9	8.9	13.3	15.6	21.1	55.6
	1200	6.8	6.8	15.3	18.9	29.7	51.4
	1800	5.6	6.0	10.2	12.6	21.4	47.0
Summer	0000	1.3	1.3	1.3	2.0	8.7	47.3
	0600	1.7	1.7	2.5	2.5	4.2	29.3
	1200	1.5	1.5	2.2	2.9	6.5	20.0
	1800	0.8	0.8	2.8	3.6	15.9	40.5
Fall	0000	2.3	2.3	5.6	6.2	11.9	37.9
	0600	1.8	1.8	5.8	6.6	10.9	27.7
	1200	1.9	1.9	4.1	5.8	10.7	24.0
	1800	3.4	3.4	5.7	6.4	11.7	32.2

TABLE 13. Cumulative Percent of Visibilities Less Than or Equal to Threshold Values at Tegucigalpa for 1973-1981.

Season	Hour	Visibility Threshold (miles)					
		≤0.62	≤1	≤2	≤3	≤5	≤10
Winter	0000	0.0	0.0	0.4	0.9	3.9	16.8
	0600	0.5	0.5	1.6	1.8	8.3	26.5
	1200	0.0	0.0	0.3	0.3	3.2	10.8
	1800	0.2	0.2	0.4	0.5	3.2	11.1
Spring	0000	0.4	0.4	1.9	4.1	16.0	44.7
	0600	3.0	3.0	5.9	8.7	22.8	48.2
	1200	1.8	2.0	3.9	6.5	15.3	30.1
	1800	1.7	1.7	5.2	8.1	19.0	31.8
Summer	0000	0.2	0.2	0.6	0.8	5.7	29.8
	0600	0.6	1.0	4.1	5.1	16.5	45.6
	1200	0.2	0.2	0.8	1.0	4.8	16.1
	1800	0.6	0.6	2.4	3.9	8.4	22.7
Fall	0000	0.2	0.2	2.1	3.3	10.4	37.1
	0600	1.5	1.5	3.6	6.4	18.0	48.3
	1200	0.2	0.2	0.8	1.0	2.7	12.7
	1800	0.2	0.4	2.6	3.7	11.0	25.5

TABLE 14. Contingency Table of Observations Classified According to Visibility and Cloud Amount for 1973-1981 at Tela.

Visibility (miles)	Cloud Amount				
	0	1-4	5-7	8-9	Total
V≤0.62	46 (0.7)	32 (0.5)	12 (0.2)	91 (1.3)	181 (2.6)
0.62<V≤5	30 (0.4)	104 (1.5)	201 (2.9)	369 (5.3)	704 (10.1)
5<V≤10	31 (0.4)	275 (4.0)	708 (10.2)	295 (4.2)	1309 (18.8)
10<V	203 (2.9)	1911 (27.5)	2368 (34.1)	273 (3.9)	4755 (68.4)
TOTAL	310 (4.5)	2322 (33.4)	3289 (47.3)	1028 (14.8)	6949 (100.0)

Note: Numbers in parentheses are percents.

TABLE 15. Contingency Table of Observations Classified According to Visibility and Cloud Amount for 1973-1981 at Tegucigalpa.

Visibility (miles)	Cloud Amount				
	0	1-4	5-7	8-9	Total
V≤0.62	6 (0.0)	22 (0.2)	27 (0.2)	33 (0.2)	88 (0.6)
0.62<V≤5	65 (0.5)	218 (1.6)	650 (4.6)	394 (2.8)	1327 (9.5)
5<V≤10	52 (0.4)	369 (2.6)	1554 (11.1)	485 (3.5)	2460 (17.6)
10<V	367 (2.6)	3404 (24.3)	5964 (42.6)	399 (2.8)	10134 (72.3)
TOTAL	490 (3.5)	4013 (28.6)	8195 (58.5)	1311 (9.4)	14009 (100.0)

Note: Numbers in parentheses are percents.

TABLE 16. Mean Wind Speeds in m/sec for Tela and Tegucigalpa for the Period 1973-1981.

Station	Season	HOUR			
		0000	0600	1200	1800
Tela	Winter	1.2	0.6	2.7	2.2
	Spring	1.1	0.4	3.4	3.5
	Summer	1.0	0.4	3.5	3.6
	Fall	0.8	0.6	2.9	1.8
Tegucigalpa	Winter	2.8	2.3	4.8	4.5
	Spring	2.6	1.6	4.1	4.4
	Summer	1.8	1.5	4.0	3.8
	Fall	2.0	1.8	4.4	3.7

TABLE 17. Monthly Distribution of the Percent of Wind Speeds Greater Than or Equal to Two Threshold Values at Tela, Honduras (US Air Weather Service, 1968).

	MONTH											
	J	F	M	A	M	J	J	A	S	O	N	D
% $\geq$ 17 knots (8.74 m/sec)	0.8	4.2	4.8	0.0	1.1	0.0	0.0	0.0	0.7	0.6	3.7	2.7
% $\geq$ 28 knots (14.40 m/sec)	0.0	1.0	1.2	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.6	0.9

TABLE 18. Frequency Distributions of Wind Speed (m/sec) at Swan Island, Honduras.

Month	Min	Probability Thresholds (%)								Mean	Max.	σ	No. Obs.
		5.0	10.0	15.9	50.0	84.1	90.0	95.0	99.0				
January	0	2.1	2.8	3.6	5.1	8.0	8.8	9.5	11.4	5.6	13	2.1	421
February	0	2.2	3.2	3.7	5.4	8.5	9.1	10.0	12.1	5.9	15	2.2	377
March	0	2.0	3.0	3.7	5.5	8.7	9.2	10.3	12.4	6.0	15	2.3	415
April	0	2.3	3.3	3.7	5.2	8.1	8.8	9.7	10.5	5.7	11	1.9	414
May	0	2.0	2.8	3.6	4.9	7.0	7.5	8.5	9.3	5.1	10	1.7	426
June	0	2.2	3.5	3.8	5.6	8.1	8.8	9.6	10.5	5.8	11	2.0	418
July	0	2.2	3.0	3.6	5.0	7.0	7.4	8.5	9.4	5.2	10	1.6	429
August	0	1.8	2.3	3.0	4.6	6.4	7.0	7.5	9.2	4.7	10	1.5	428
September	0	1.6	2.0	2.6	4.6	7.1	8.2	9.4	11.2	4.9	12	2.2	432
October	0	0.7	1.6	2.1	4.3	6.6	7.2	8.3	10.4	4.4	13	2.1	416
November	0	2.0	2.8	3.5	4.9	7.3	8.2	9.1	10.9	5.3	12	1.8	413
December	0	2.1	3.0	3.7	5.2	8.4	9.0	9.5	11.4	5.8	13	2.2	422

TABLE 19. Annual Average Percent of Observations as a Function of Wind Speed Versus Wave Height in the Caribbean Sea North of Honduras Near British Honduras (Naval Weather Service Command, 1974).

Wave Height (feet)	Wind Speed (knots)						Total
	0-3	4-10	11-21	22-33	34-47	≥ 48	
< 1	4.1	3.7	0.1	0.0	0.0	0.0	8.0
1-2	2.2	20.3	8.2	0.0	0.0	0.0	30.7
3-4	0.2	13.5	22.1	0.5	0.0	0.0	36.3
5-6	0.0	2.0	13.7	2.1	0.0	0.0	17.7
7	0.0	0.3	3.7	0.8	0.0	0.0	4.9
8-9	0.0	0.1	1.2	0.6	0.0	0.0	1.9
10-11	0.0	0.0	0.1	0.2	0.0	0.0	0.3
12	0.0	0.0	0.1	0.0	0.1	0.0	0.2
13-16	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26-32	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33-40	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41-48	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49-60	0.0	0.0	0.0	0.0	0.0	0.0	0.0
61-70	0.0	0.0	0.0	0.0	0.0	0.0	0.0
71-86	0.0	0.0	0.0	0.0	0.0	0.0	0.0
≥ 87	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	6.5	39.9	49.2	4.2	0.1	0.0	100.0

TABLE 20. Annual Average Percent of Observations as a Function of Wind Speed Versus Wave Height in the Pacific Ocean South of Honduras Near Nicaraugua (Naval Oceanography Command Detachment, 1981).

Wave Height (feet)	Wind Speed (knots)						
	0-3	4-10	11-21	22-33	34-47	≥ 48	Total
< 1	14.5	10.6	0.3	0.0	0.0	0.0	25.5
1-2	3.7	27.7	5.8	0.0	0.0	0.0	37.3
3-4	0.6	11.9	9.9	0.4	0.0	0.0	22.8
5-6	0.2	2.4	6.3	0.6	0.0	0.0	9.5
7	0.0	0.4	2.1	0.6	0.0	0.0	3.2
8-9	0.0	0.1	0.6	0.3	0.0	0.0	1.0
10-11	0.0	0.0	0.1	0.2	0.0	0.0	0.4
12	0.0	0.0	0.0	0.1	0.0	0.0	0.1
13-16	0.0	0.0	0.0	0.0	0.0	0.0	0.1
17-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20-22	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23-25	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26-32	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33-40	0.0	0.0	0.0	0.0	0.0	0.0	0.0
41-48	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49-60	0.0	0.0	0.0	0.0	0.0	0.0	0.0
61-70	0.0	0.0	0.0	0.0	0.0	0.0	0.0
71-86	0.0	0.0	0.0	0.0	0.0	0.0	0.0
≥ 87	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	19.1	53.3	25.3	2.2	0.1	0.0	100.0

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